EVALUATING AND DELIVERING THE U. S. ARMY AIRCREW COORDINATION TRAINING ENHANCEMENT (ACTE) PROGRAM

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ABSTRACT

The Aircrew Coordination Training Enhancement program is a continuation of the US Army Research Institute (ARI) priority to promote applied research and development (R&D) of the Army Aircrew Coordination Training (ACT) program. The goal of the ACT Enhancement effort is to provide a web-delivered, interactive aircrew coordination training system that provides Army aircrews worldwide with the knowledge and skill-sets needed to increase flight safety and mission effectiveness in daily operations. The research plan consists of three major phases – upgrade and sustain the existing ACT program, refresh and maintain the upgraded ACT program, and deploy advanced ACT applications.

This paper describes objectives and outcomes of ongoing high performance team training system R&D under the guidance of ARI. The prototype products from the first phase of research include two interactive multimedia courses of instruction with supporting training materials. Development of courseware web application components and production of graphics are achieved with a suite of Macromedia Flash and Dreamweaver UltraDev authoring tools. The Aircrew Course and Instructor Course include a fully integrated Data Management System that tracks student demographics, provides graphic feedback displays during evaluation exercises, and facilitates electronic course critiques. User testing and validation results indicate high levels of acceptance for both the training and performance evaluation components. Initial testing of the prototype courseware on the Army's distance learning suite supports both the web-based and instructor facilitated delivery strategies for Army-wide implementation. The ACT event-driven scenarios serve as model constructs for integration of ACT into advanced aircraft simulators and multiple aircraft training exercises supported by distributed interactive simulation. Ongoing research activities include developing web-based training support packages and institutional training to support Flight School XXI. Training effectiveness results have led the Army to initiate research into applying the ACTE courseware design and delivery model to other than aviation systems.

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Mr. Gary Grubb is the director of the Dynamics Research Corporation's Center for Team Performance and manages the ACTE program. He has published numerous team coordination research papers and designed, developed, implemented and evaluated ACT/CRM programs for the Army and Air Force. A former Army aviator, he has a MS in Management.

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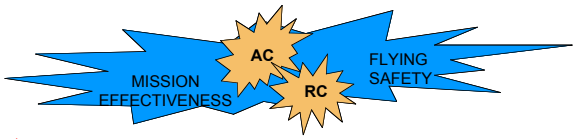
INTRODUCTION

Aircrew Coordination Training (ACT) and Crew/Cockpit Resource Management (CRM) programs were instituted in the 1980's, first in commercial aviation and later in military aviation, to address adverse mishap rate trends that showed the inability of many aviators to work well together in periods of high stress or workload (Helmreich, Merritt, & Wilhelm, 1999). Minor aircraft malfunctions were resulting in fatal accidents with alarming regularity. While aviators generally displayed excellent knowledge and understanding of aircraft systems, operating procedures, rules and regulations and other technical information, they often displayed a glaring inability to communicate effectively, distribute workload, maintain or regain situational awareness and make sound decisions. Military aviation took note of the success of CRM in the civilian sector and instituted similar training programs (Orlady & Foushee, 1987).

During fiscal years 1984-1989, crew coordination failures identified by the Army Safety Center directly contributed to the loss of 147 lives and $292 million in aviation accident costs. In 1990, Army leadership directed the Army Aviation Center to focus its aviation training and evaluation on crew performance. The Army Research Institute (ARI) worked closely with Army aviation training, evaluation, and safety personnel to develop, validate, and field an ACT Exportable Training Package. The U.S. Army implemented its version of Aircrew Coordination Training (ACT) in 1994 based on previously completed R&D (Department of the Army, 1992).

Commanders and aircrews alike acknowledged the benefit of the mandatory, one-time training that was received by all aviators within the Army aviation community. The initial program did not address sustainment issues and did not package the training in a program that would facilitate such training. Therefore, sufficient funds were not provided for developing a program to sustain this important training. Funding issues notwithstanding, significant personnel turbulence associated with downsizing the force since the 1994 program inception has resulted in a natural erosion of the safety gains initially realized as a result of ACT. Finally, the atrophying of skills and the lowering of experience levels that has occurred during successive years of limited defense funding have now manifested themselves in a sharp increase in accident and incident rates.

Lack of effective aircrew coordination continues to be cited as a definite or suspected contributing factor in aviation flight accidents, and it is a factor limiting attainment of the full mission effectiveness of Army aviation. The Aviation Safety Investment Strategy Team (see Figure 1) was chartered in 1999 to define measurable accident prevention goals and identify the most important Army-wide investments needed to achieve them. The ASIST study reported that a crew coordination sustainment-training program would help attain the Army accident reduction goals at the least investment cost (Hicks & Puesch, 2000).



- **Personnel Turbulence and Operations Tempo**
- **Increasing Reliance on Active-Reserve Unit Mix**
- **Aviation Safety Investment Strategy Team (ASIST)**
  - In-depth analysis of accident experience
  - All force-modernized aircraft during FY 94-98
  - Eight of top ten hazards (290 total hazards) are crew coordination related
  - Number four of top ten controls (249 total controls) is crew coordination related

Develop, monitor, and evaluate a Crew Coordination Sustainment Training program integrated into aviation tasks (Control Number 4 in "One to Goal List")

Figure 1. Aviation Safety Investment Strategy Team (ASIST)

This paper describes the results of Phase I of the research and development initiative directed by the U. S. Army Research Institute (ARI) to enhance the Army's Aircrew Coordination Training program through upgraded training content and state of the art distributed learning technology.

DESCRIPTION OF ACTE PHASE 1 ENHANCEMENT OBJECTIVES

The objective of the research effort to enhance Army ACT is to improve the crew and team coordination effectiveness of Army aircrews in their day-to-day mission planning and flight operations. Establishing and maintaining a unit-level command climate that promotes the use of team coordination behaviors will realize this objective and places equal emphasis on technical and team coordination skills in daily flight operations. Instructor pilots and ACT facilitators in aviation units are key to the institutionalization of a successful ACT program.

The current enhancement program managed by the ARI is a multi-year, multiphase program of applied research structured in three major phases – upgrade and sustain the existing ACT program, refresh and maintain the upgraded ACT program, and deploy advanced ACT applications.

Phase I of the enhancement effort to upgrade and sustain the current ACT program is completed. Two ACTE prototype courseware programs have been delivered to ARI, the Aircrew Course and the Instructor Course. Each course of instruction is the integration and end product of:

- Analysis of the current aircrew coordination training program.
- Definition of evaluation tools and techniques for assessing along specific behavioral proficiency dimensions overall crewmember team performance.
- Development of prototype focused interventions for training and evaluating team coordination behaviors and for managing risk.
- Validation of prototype team training and evaluation techniques in selected aviation units.
- Field-testing of prototype training, evaluation, and technology products.

ACTE PHASE I ENHANCEMENT PRODUCTS

When the Phase I prototype products are fully developed and deployed, the Aircrew Coordination Training Enhancement (ACTE) program will provide mission-oriented sustainment training and provision for web-accessible updates.

Simplified Performance Evaluation System

The products necessary to provide a simplified performance evaluation system consisted of a practical assessment methodology and a suite of quantitative, field-usable measures to allow across-platform and across-crew configurations evaluation of ACT behaviors and skills. Implementing the evaluation system required a tool for recording ACT performance evaluations to support facilitation of team performance improvement during the after-action review.

The central product is a set of observable measures of individual and collective behavior, the Behaviorally Anchored Rating System (BARS). The BARS were gleaned from extensive research across DoD and Commercial aviation communities and served as a precursor to courseware content design and development. The BARS evaluation criteria are based on issues relevant to both rated and non-rated aircrew members in rotary wing and fixed wing environments and serve as the benchmarks against which crew team behaviors are evaluated.

The measurement of aircrew coordination behavior is a critical component of the aircrew coordination program and is central to the training content design and delivery. The vehicle for documenting these evaluations is the ACT Performance Evaluation Checklist (see Attachment 1) which is based on the 5 Crew Coordination Objectives (CCO) and 13 Basic Qualities (BQ) accepted by the Army as descriptors of aircrew coordination behavior. ACT behaviors and skills are organized by CCO and are rated using a seven-point scale with values ranging from 1 (Below Standards) to 7 (Exceeds Standards). The BARS numeric rating scale is shown at the bottom of the ACT Performance Evaluation Checklist.

Below Stand-ards			Meets Stand-ards			Exceeds Stand-ards
1	2	3	4	5	6	7

Figure 2. BARS Numeric Rating Scale

Written descriptions are provided for the ACT behaviors and skills and levels of performance for rating aircrews at the values of 1, 4, and 7. These descriptions serve as behavioral "anchors" and are designed to assist in determining how well an aircrew performs ACT behaviors and skills in relation to a well-defined set of performance criteria. The anchors are used as the standard for evaluating ACT performance. This avoids the trap of norm referencing, i.e., comparing one aircrew's performance with that of another. An aircrew's performance is always rated solely in relation to the "anchors." This has long-term implications for the objective measurement of aircrew coordination improvement.

Aircrew Course

The Aircrew Course consists of five modules of instruction: Introduction, an ACT Principles and Risk Management Review module (see Attachment 2), a Case Study, a Problem Solving Exercise, and a Conclusion.

Both the Principles Review and Risk Management modules employ extensive use of narrated audio video files. The narration guides the user through the course material while the AV files provide support at the exact time of cognitive need. Comprehension checks provide learners the opportunity to check their retention and feedback relating to their understanding of important information. A linked list of related topics is provided on each topic header page for those aircrew members who desire a more in-depth review.

The case study module provides an opportunity for aircrew members to become familiar with the Aircrew Guide, the performance evaluation system, and the BARS for their use in promoting and evaluating team coordination behaviors. Once they have reviewed the Aircrew Guide, students are presented a current case study. A central feature of the case study is an AV vignette based on an actual Army aviation event that focuses on automation or crew configuration related accident or incident trends. Once students observe the vignette, they are given the opportunity to evaluate aircrew behaviors using the on-line electronic ACT Performance Evaluation Checklist. Their individual responses are aggregated as a histogram and displayed to the class to serve as the basis for instructor-facilitated discussion to achieve learning objectives.

Finally, the learners are presented a problem solving exercise in which they are given the opportunity to apply their ACT knowledge and evaluation skills to a simulation derived from actual events and experiences in the field.

Instructor Course

The Instructor Course consists of six modules of instruction: Introduction, ACT Instructional Setting module, Evaluation Tools and Techniques, Observation and Evaluation Exercise, a module on Facilitation Skills, and a Conclusion.

Completion of the ACTE Aircrew Course by unit instructor pilots (IP) is a prerequisite to attending the Instructor Course. Courseware content builds on the crewmember skills learned during the Aircrew Course. The ACT Instructional Setting module emphasizes the ACT Instructor's role in an operational unit. Presentation approaches and features similar to those used in the Aircrew Course provide in-depth instruction and practice exercises on applying the ACT Performance Evaluation System tools and techniques to achieve reliable ratings of observed aircrew situations. The use of vignettes and the electronic Performance Evaluation Checklist supports practice exercises in the Facilitation Skills module.

Courseware support materials for the Instructor Course include an Instructor Guide and ACT event driven scenario outlines for use in simulator or aircraft evaluations of aircrew ACT performance.

Courseware Delivery

Both the Aircrew and Instructor courses are WEB accessible. A number of distribution tests were conducted throughout the testing and pre-fielding periods of Phase I. In each test, the courseware ran without significant error and the few technical issues presented were easily remedied with minor technical adjustments to the underlying programming. Importantly, the distribution tests confirmed the utility of the ACTE courseware for simultaneous consumption to geographically dispersed audiences. Additionally, distribution of the courseware in both a private LAN and CD ROM format were tested and confirmed (see Figure 3).

The outcome of the testing of courseware components ensures that the Army aviation community can make ACTE available to aviators worldwide.

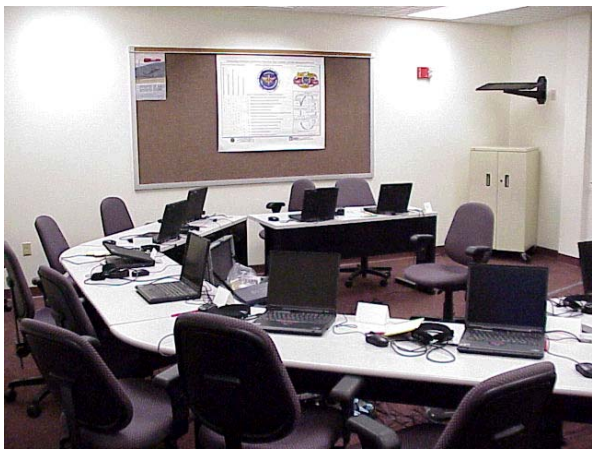


Figure 3. Local Area Network Delivery

ACTE EFFECTIVENESS RESULTS

The effectiveness of the ACTE training and evaluation components was measured at increasing levels of fidelity and scope. The first field measurement of the

core modules occurred in the demonstration and validation of the completed prototype Aircrew and Instructor courses followed by operational field-testing of the complete set of training and evaluation products associated with both courses.

Demonstration and Validation

The demonstration and validation of the effectiveness of the Aircrew and Instructor courses occurred as a two-part process consisting of a usability assessment and a field study.

For the **usability assessment**, use of the courseware was observed and assessed in selected Army National Guard (ARNG) aviation units that represented cargo and observation aircraft, missions, and operating conditions. A form of summative evaluation, the usability assessment employed the prototype courseware in a field setting using representative groups of the target training audience. Data was gathered on Aircrew and Instructor course courseware usability, effectiveness, and areas of needed interface and content improvement.

Using unit classrooms and facilities, contractor instructors presented the Aircrew and Instructor Courses in two-four hour periods each using the contractor provided LAN of notebook computers. Army Research Institute reviewed and approved the automated data collection items revised from the User Pretest. Units identified and scheduled 20 participants to provide a cross section of highly experienced aircrew members and instructors. Participant ratings averaged 4.0 or higher on a 5-point scale.

- Courseware structure and navigation logical and understandable (4.0)
- Comprehension checks understandable (4.1)
- Amount of information, pace and time good (3.0 on 5-point scale with 3.0 optimal)
- Mission vignettes allowed observation and related ACT to RM (4.0)
- Instructor knowledge, preparation, and clarity (4.6)
- Student workstation equipment (4.6)
- Performance Evaluation System and Aircrew Guide helpful (4.2)
- Content relevant (4.3)
- Positive effect on flying safety (4.4)
- Effect as refresher to previous ACT (4.2)
- Positive effect on mission effectiveness (4.0)
- Lessons helped understand how to identify ACT behaviors (4.1, Instructor Course)
- Lessons helped understand how to evaluate ACT performance (4.0, Instructor Course)
- Lessons helped understand how to facilitate ACT performance improvement (4.1, Instructor Course)
- Instructor Evaluator Guide helpful for implementing ACT in daily ops (4.3, Instructor Course)

The subsequent analysis of usability assessment ratings and comments indicated wide and enthusiastic acceptance of the courseware as necessary and beneficial to Army aviation flight safety.

The **field study** was designed as an experiment to compare units that received the prototype ACTE training and evaluation instruction with units that had not. Field study participants were aviation units that represented utility aircraft, missions, and operating conditions. The intended experimental design required both attack and utility aircraft equipped units. Attack aircraft units were not available to participate in the field study due to operational requirements in response to terrorist attacks. Pressing operational requirements limited the availability of participating utility aircraft units and forced removal of the control group from the experiment. As a result, the experiment provided indicators of relative movement due to training and supported descriptive, graphical, and user comments analysis (see Table 1).

Table 1. Field Study Measures

Measurement Area	Measurement Instruments
ACT Behaviors	• Performance Evaluation Checklist • Behaviorally Anchored Rating System (BARS)
ATM Task Performance	• Scenario Worksheets
Mission Effectiveness	• Scenario Worksheets
Crew Related Errors	• Scenario Worksheets
Course Critique	• Data Management System Scalar Critique Items • Data Management System Open-ended Items

Prototype courseware for the Aircrew and Instructor Courses was used to train observer-evaluators, establish inter-rater reliability, and standardize the field study scenarios. Once observer-evaluators were trained, a total of 35 unit leaders, instructor pilots, and aircrews participated in structured training and evaluation events (see Figure 4).

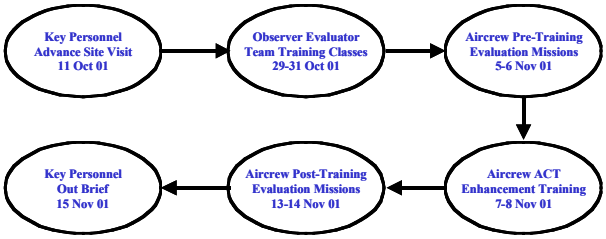


Figure 4. Field Study Events

As in the usability assessment, field study data were analyzed and the findings reported to the Aircrew Coordination Working Group. Analysis results indicated measurable differences between pre and post training mission effectiveness and flying safety attributable to the enhanced training and evaluation prototype products.

- Team Relationships increased 18%
- Maintaining Workload Levels increased 19%
- Mission Information Exchange increased 23%
- Cross-monitoring Performance increased 13%
- Successfully Managing Mission Threatening Error increased 30%
- Mission Segments Completed increased 20%
- Number of Aircraft Crashes decreased 67%

Operational Field Test

For the final operational field test, use of the courseware was observed and assessed in both Army National Guard (ARNG) and Army Active Component (AC) aviation units that represented cargo, attack, and utility aircraft, missions, and operating conditions. A form of operational evaluation, the field test employed the prototype courseware in a field setting using representative groups of the target training audience. Data were gathered on Aircrew and Instructor course courseware usability, effectiveness, and areas of needed interface and content improvement.

As in the usability assessment and field study events, contractor instructors used unit classrooms and facilities to present the Aircrew and Instructor Courses to a cross section of 31 highly experienced aircrew members and instructors. Participant ratings averaged 4.0 or higher on a 5-point scale.

- Tutorial effectiveness (4.0)
- Courseware structure and navigation logical and understandable (4.1)
- Amount of information, pace and time good (3.1 on 5-point scale with 3.0 optimal)
- Instructor knowledge, preparation, and clarity (4.4)
- Content relevant (3.8)
- Positive effect on flying safety (4.0)
- Effect as refresher to previous ACT (4.1)
- Positive effect on mission effectiveness (4.3)
- Lessons helped understand how to identify ACT behaviors (3.9, Instructor Course)
- Lessons helped understand how to evaluate ACT performance (4.2, Instructor Course)
- Lessons helped understand how to facilitate ACT performance improvement (4.0, Instructor Course)
- Instructor Evaluator Guide helpful for implementing ACT in daily ops (4.0, Instructor Course)

The prototype courseware and support materials are ready for final approval and subsequent fielding and employment by Army aviation units worldwide.

ROADMAP FOR FURTHER ENHANCEMENT OF ACT

The persistent challenge is how to sustain and advance the cultural and team performance improvements achieved by initial ACT training and enhancements. Key elements for an effective long-range strategy include actions to:

- Fully integrate ACT into the organizational structure, command climate, rules, and regulations that set the stage for daily flying operations.
- Institute ongoing ACT program evaluation and sustainment activities to keep training realistic and relevant to operational missions and conditions.
- Correlate accident investigation and accident data analysis to the ACT program structure (behaviors) so that accident investigation data can be used to target specific areas of the ACT training program for increased emphasis.
- Include instruction on strategies, tools, and techniques that apply ACT behaviors and skills to manage risk and avoid, trap, or mitigate aircrew error.

ACTE Phase II research is currently underway and will further advance the upgraded program by designing and delivering a comprehensive train-the-trainer course; developing training support packages for specific aircraft and missions; integrating ACT into Nonrated crewmember and Flight School XXI institutional courses; developing a prototype evaluation-based feedback system; and including ACT in distance learning developments.

Phase III research will focus on incorporating the products of Phase I and II as part of normal operations and deploying advanced ACT applications.

It will include the development of ACT event-driven scenarios for multiple aircraft missions and extending ACT scenarios to advanced simulators and distributed interactive simulation training exercises.

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ACT Performance Evaluation Checklist

For use of this form, see the ACT Aircrew Guide

CCO	BQ	Crew Coordination Objectives (CCO)/Basic Qualities (BQ)	Rating
1		Establish and Maintain Team Relationships	
	1	Establish and Maintain Team Leadership and Crew Climate	
2		Mission Planning and Rehearsal	
	2	Pre-mission Planning and Rehearsal Accomplished	
	3	Application of Appropriate Decision Making Techniques	
3		Establish and Maintain Workload Levels	
	4	Prioritize Actions and Distribute Workload	
	5	Management of Unexpected Events	
4		Exchange Mission Information	
	6	Statements and Directives Clear, Timely, Relevant, Complete and Verified	
	7	Maintenance of Situational Awareness	
	8	Decisions and Actions Communicated and Acknowledged	
	9	Supporting Information and Actions Sought from Crew	
5		Cross-Monitor Performance	
	10	Crewmembers Actions Mutually Cross-Monitored	
	11	Supporting Information and Actions Offered by Crew	
	12	Advocacy and Assertion Practiced	
	13	Crew/Flight After-Action Reviews Accomplished	

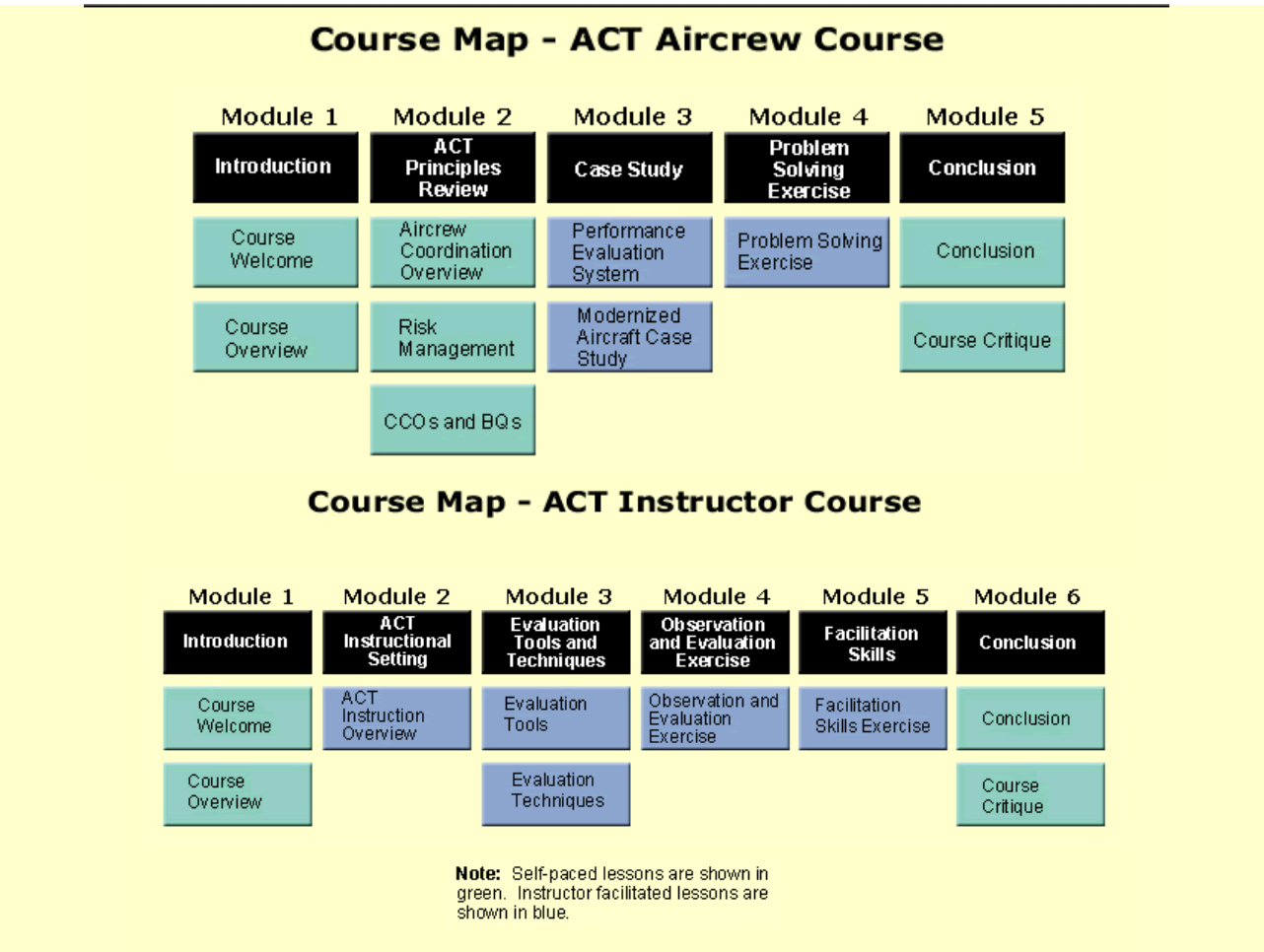
Remarks: (Use continuation sheet[s] if necessary)

Notes:

Consult the ACT Aircrew Guide evaluation procedures and guidelines. Enter a summary rating (1 – 7) in the rating block for each ACT Crew Coordination Objective (CCO). Refer to the rating scale below.

Below Standards			Meets Standards			Exceeds Standards
1	2	3	4	5	6	7

Attachment 1. ACT Performance Evaluation Checklist



Attachment 2. ACT Course Maps